TECHNICAL LITERACY SERIES

1

COMPUTER
THE MAGIC OF COMPUTERS

National Education Corporation

G4701

SCHOOL OF COMPUTER TRAINING

PROGRAMMING IN BASIC
STUDY UNIT 1

THE MAGIC OF COMPUTERS

Edition 2
Reprinted 1984

STUDY UNIT 1

YOUR LEARNING OBJECTIVES

WHEN YOU COMPLETE THIS UNIT, YOU WILL BE ABLE TO:

☐ Understand what a computer does and how it works . . **Page 1**

☐ Understand the main historical developments that have led to the computer "revolution" . . . . **Page 4**

☐ Realize basic differences among mainframe, minicomputers and microcomputers . . . . **Page 8**

☐ Know how computers evolved from large mainframes to microcomputers . . . . **Page 9**

☐ Identify the main components of a microcomputer system . . . . **Page 10**

☐ Understand three ways that you can input instruction to your microcomputer . . . . **Page 11**

☐ Identify two types of "memory" that a microcomputer uses to carry out its functions . . . . **Page 11**

☐ Identify needs which can be fulfilled by computer programs . . . . **Page 14**

☐ Begin to understand basic components of computer languages, and what languages microcomputers "understand" . . . . **Page 15**

☐ Understand how to write a short program in BASIC Language . . . . **Page 20**

☐ Write a very simple program, to discover how you can interact with a computer . . . . **Page 20**

STUDY UNIT 1

THE MAGIC OF COMPUTERS

DO YOU KNOW?

- **How micro "chips" are revolutionizing our lives?**
- **What language is used by micro and personal computers?**
- **How computers operate: what they can and cannot do?**

THE GENIE IN THE LAMP

Few tales have been told as often or relished as much as the stories in *Arabian Nights.* Of special fascination, the episodes of the *Genie in Aladdin's Lamp* have captivated young and old alike.

Normal fantasy will have the magical genie (once unleashed from Aladdin's magic lamp) granting three wishes—of any magnitude—to an astounded recipient. The outcomes of these episodes come out good, bad or indifferent, depending on the greed, courage and other traits of the beneficiary.

Tales of the genie have been enjoyed in every medium throughout history. The omnipotent genie has magically appeared in movies, on television, on radio and in print.

Our ancient genie has been very entertaining, and quite often has provided sound moral lessons for us all. So far, though, no *real* genie has ever appeared from *any* type of lamp. It exists only in the collective imagination of a worldful of people.

A *REAL* MODERN GENIE?

In today's world, we have come a bit closer to having a real genie at our command.

This new genie, like the ancient one, fulfills requests at *lightning speed.* To date, it has racked up quite a number of *real* accomplishments, like:

- guiding spaceships into and out of the earth's atmosphere.
- operating fully automated manufacturing systems.
- transmitting millions of dollars thousands of miles in but a few seconds.
- carrying out medical research to find new cures for disease.

These are but a few examples of what our modern genie is *doing* today.

If you've guessed that our modern genie is a *computer*, you are quite correct.

If you think that we have exaggerated the capabilities of computers, *you are NOT correct*. Computers are doing these things and more, and yes, we are into the computer age. Computers are here, there and everywhere.

They are in markets, medical offices, gasoline stations, cocktail lounges, accounting offices, banks, department stores, radio and TV stations, schools, and in any other type of business that you can name.

They are in automobiles, ovens, typewriters and other office machines.

They are in homes.

And, oh, yes—they are in entertainment arcades.

You are most likely interacting with a computer right now. Bills that you receive or letters in your mailbox offering sale of merchandise were likely generated by a computer. If you have a savings account, the computer is probably keeping track of it for you.

They are workhorses. And once you've harnessed one properly, it will do your bidding *in an instant*—no questions asked.

Please bring entire bill if payment is made in person.
See other side for addresses of Company Offices
DETACH HERE
SOUTHERN CALIFORNIA GAS COMPANY
WILLIS E COULTER
763 JULIE DR
HNTGTN BCH CA 92647
TELEPHONE (714) 835-0221
Your Account Number 712-156-396
Rate Schedule R13

BILLING PERIOD FROM	TO	PREVIOUS	METER READINGS PRESENT	DIFFERENCE	BILLING FACTOR		THERMS
MAY 25 82	JUN 24 82	8083	8113	30	X 1.047	=	31

****
NEXT METER READING
DATE JUL 26
****

			AMOUNT
CUSTOMER CHARGE		$ 3.10	
LIFELINE THERMS	26 @ $.33949 =	8.83	
USAGE OVER LIFELINE:	5 @ .51712 =	2.59	
CITY TAX 5%		.73	
TOTAL CURRENT CHARGES			15.25
PREVIOUS BALANCE			17.41

DATE MAILED-JUN 28 1982 TOTAL AMOUNT DUE $ 32.66

GAS RATES ARE UP!
USE THESE ENERGY SAVING TIPS TO HELP KEEP GAS BILLS DOWN
REMEMBER TO TURN OFF YOUR FURNACE PILOT FOR THE SUMMER
ALSO TURN THE WATER HEATER THERMOSTAT DOWN TO WARM
FOR MORE SAVING TIPS CALL FREE 1-800-352-4124 8AM-5PM MON-SAT.

COMPARE YOUR AVERAGE DAILY USE WITH LAST YEAR

BILLING PERIOD	BILLING DAYS	THERMS BILLED	DAILY AVERAGE
THIS YEAR	30	31	1.0 THERMS
LAST YEAR	29	28	1.0 THERMS

PLEASE USE GAS WISELY

FIGURE 1—Most bills coming to home and office are computer-generated. The computer figures the amount of the bill, addresses it, and includes appropriate messages.

If you've guessed that our modern genie is a *computer*, you are quite correct.

If you think that we have exaggerated the capabilities of computers, *you are NOT correct*. Computers are doing these things and more, and yes, we are into the computer age. Computers are here, there and everywhere.

They are in markets, medical offices, gasoline stations, cocktail lounges, accounting offices, banks, department stores, radio and TV stations, schools, and in any other type of business that you can name.

They are in automobiles, ovens, typewriters and other office machines.

They are in homes.

And, oh, yes—they are in entertainment arcades.

You are most likely interacting with a computer right now. Bills that you receive or letters in your mailbox offering sale of merchandise were likely generated by a computer. If you have a savings account, the computer is probably keeping track of it for you.

They are workhorses. And once you've harnessed one properly, it will do your bidding *in an instant*—no questions asked.

Please bring entire bill if payment is made in person.
See other side for addresses of Company Offices

DETACH HERE

SOUTHERN CALIFORNIA GAS COMPANY

WILLIS E COULTER
763 JULIE DR
HNTGTN BCH CA 92647

TELEPHONE (714) 835-0221

Your Account Number: 712-156-396

Rate Schedule: R13

BILLING PERIOD FROM	TO	METER READINGS PREVIOUS	PRESENT	DIFFERENCE	BILLING FACTOR		THERMS
MAY 25 82	JUN 24 82	8083	8113	30	X 1.047	=	31

****
NEXT METER READING
DATE JUL 26
****

			AMOUNT
CUSTOMER CHARGE		$ 3.10	
LIFELINE THERMS	26 @ $.33949 =	8.83	
USAGE OVER LIFELINE:	5 @ .51712 =	2.59	
	CITY TAX 5%	.73	
	TOTAL CURRENT CHARGES		15.25
	PREVIOUS BALANCE		17.41

DATE MAILED-JUN 28 1982 TOTAL AMOUNT DUE $ 32.66

GAS RATES ARE UP!
USE THESE ENERGY SAVING TIPS TO HELP KEEP GAS BILLS DOWN
REMEMBER TO TURN OFF YOUR FURNACE PILOT FOR THE SUMMER
ALSO TURN THE WATER HEATER THERMOSTAT DOWN TO WARM
FOR MORE SAVING TIPS CALL FREE 1-800-352-4124 8AM-5PM MON-SAT.

COMPARE YOUR AVERAGE DAILY USE WITH LAST YEAR

BILLING PERIOD	BILLING DAYS	THERMS BILLED	DAILY AVERAGE
THIS YEAR	30	31	1.0 THERMS
LAST YEAR	29	28	1.0 THERMS

PLEASE USE GAS WISELY

FIGURE 1—Most bills coming to home and office are computer-generated. The computer figures the amount of the bill, addresses it, and includes appropriate messages.

Not only does it do a tremendous amount of work very quickly, very efficiently and at slave labor prices, it is also very versatile!

There are very few human activities today that are not controlled, regulated or influenced with a computer.

Yes, the computer age *is here*. And, it is at little more than the foundling stage. In point of fact, use of computers is growing by leaps and bounds. Use of computers will continue to grow because of what they can do. They will continue to influence your job, your home life and your recreational activities.

COMPUTER KNOWLEDGE IS FOR EVERYONE

Computer manufacturers are forecasting total unit sales in the millions in just the next few years. In two years time, one manufacturer has sold over half a million microcomputers worldwide. And yet, at this writing, less than 15 percent of the world's work force actually knows something about computers. This includes all levels of knowledge, not just high-powered computer expertise.

With more and more computers in use every day; with the computer influencing more and more areas of people's lives every day; how long will it be before it becomes necessary for you to know about computers—and to know how to communicate with them? It is obvious that the person with computing knowledge has the clear edge.

So how do you command this modern genie to do your bidding—to perform laborious tasks for you at lightning speed?

With Aladdin it was simpler. Aladdin's genie fulfilled requests in most any language—very literally. Modern computers understand only their own language—also very literally.

And so, the job at hand is learning how to communicate with the computer. Then you will be able to command your modern genie to carry out your wishes.

But before we get into "computer language," let's get better acquainted with the computer. Let's try to answer the question, "What is a computer, and what does it do?"

WHAT A COMPUTER IS

A computer is a device which accepts information, processes it, and supplies results. A computer may be compared to a calculator. However, the computer can perform operations without human assistance, and at speeds far greater than any human could perform them.

Actually, at one time computers were little more than oversize calculators. Their prime task then was computing in the arithmetic sense: adding, subtracting, multiplying and dividing. But that day is long past. Today's computer needs to be described in a number of different ways because today, computers do more than compute.

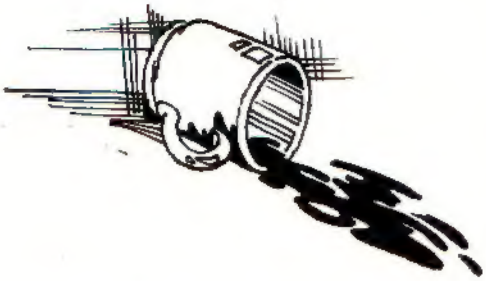
And you can't tell a computer by its looks. The two instruments in Figure 3 look alike, and they might easily be mistaken for "typical" computers. But one is not a computer at all! Many people, having seen television and magazine ads, think of computers in this keyboard and cathode-ray-tube form. But defining a computer by what it looks like can prove misleading: what you see may or may not be a computer.

Describing the components that make up a computer is also an incomplete definition of a computer: not all computers contain the same components.

Neither does a job description tell us what a computer is. It could portray one particular type of computer, but it would not clarify what the general term "computer" means.

Better, we should consider what a computer does.

COMPARING OUTPUT WITH SPILLED COFFEE...



Some computers are capable of recalling information from internal storage at a rate that is measured in microseconds (millionths of a second), nanoseconds (billionths of a second), or picoseconds (trillionths of a second). For example, within the half second it takes to spill a cup of coffee on the floor, a large computer can debit 2,000 checks to 300 different bank accounts; examine the electrocardiograms of 100 patients and alert a physician to possible trouble; score 150,000 answers on 3,000 examinations; figure the payroll for a company with 1,000 employees; and have spare time remaining.

FIGURE 2—A large mainframe is capable of performing several large runs simultaneously. A micro or personal computer can perform only one run at a time.

WHAT A COMPUTER DOES

You will come to understand a computer best by gaining an understanding of its basic activities:

1. A computer accepts instructions that tell it how to operate.
2. A computer takes in data from one or more sources.
3. A computer processes data according to the instructions put into it.
4. A computer stores data (remembers) sometimes temporarily, sometimes more permanently.
5. A computer sends data to devices that display the data for an operator to read (TV screen or monitor), or sends it to instruments which in turn control other equipment (printers or typewriters or cassette players).

Fundamentally, then, a computer is a device which manages data and information.

AN ANCESTRAL HISTORY OF COMPUTERS

We have alluded to the fact that modern-day electronic computers are genie-like. True. They are, in terms of many results produced.

To set the record straight, however, we need to point out that the grandfather of all computers is the abacus, not the genie. (Aladdin had nothing to do with it.)

FIGURE 3—Although these two units look much alike, they are actually quite different. That's a self-contained microcomputer on the left; the unit on the right is only a terminal. It has no built-in computer; instead, an operator sends and received data to and from a host computer located elsewhere.

Computing devices of one kind or another have been known for over 5,000 years. The most widely used computing device in ancient times was the abacus. The abacus is still in use today, mainly in the Far East, and particularly in China, India, and Japan. And those skilled in its use will amaze you with how quickly and expertly they can make calculations.

Despite the long history of the abacus, however, it is only recently that computer-like mechanical devices were invented. The first mechanical calculator that could be called a computer was developed in 1812 by Charles Babbage, a British mathematician. The machine computed tables of mathematical functions.

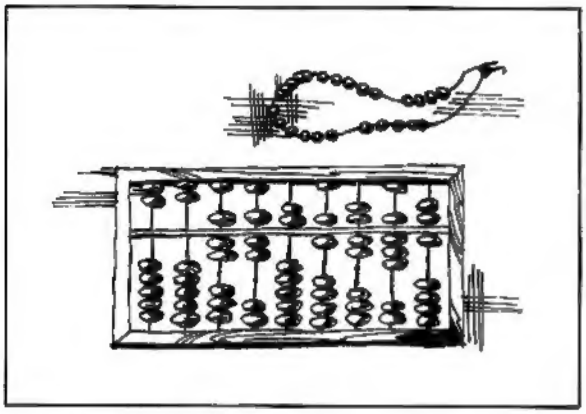


FIGURE 4—The abacus has been used as a data processor for over 4,000 years. Beads on a string or leather thong have also served the same purpose as a counting device.

The important concept of sequential control initiated by Babbage laid the foundation for the first generation of modern computers. Unfortunately, financial difficulties and engineering problems prevented the machine itself from becoming a reality.

First-Generation Computers

Babbage's principle of sequential control formed the basis for the development of Mark I, a machine constructed by Dr. Howard Aiken of Harvard University. The Mark I employed the technique of opening and closing electromagnetic relay switches to do its counting. Begun in the 1930s, the Mark I was not completed until 1944. It was developed through the combined efforts of Harvard University and the International Business Machines Corporation.

The concept of placing instructions in the memory unit of a computer was introduced by Dr. John von Neumann in 1945. In addition to this stored program concept, which is basic to modern computers, Dr. von Neumann further suggested the use of binary numbers instead of decimal numbers in order to achieve greater equipment power at considerably less expense.

A significant advance was made in computer-building technology with the use of vacuum tubes in the internal operation of the computer. The first

WHY USE ELECTRONIC DATA PROCESSING EQUIPMENT?

- **Tasks which are repetitive can be more easily done by machine than by human labor.**
- **Tasks can be done faster by machine.**
- **Tasks can be done more accurately.**
- **Volume of tasks has increased to where it is less costly to do by machine.**
- **Machines free employees to perform more appropriate and challenging tasks.**
- **Machines provide accurate monitoring of task performance in forms of results, displays, printouts.**
- **Machines can simultaneously produce a variety of results otherwise difficult to obtain using manual calculation and human reasoning.**

FIGURE 5—These are just some of the reasons why companies lease or purchase electronic data processing equipment. Industrial applications often enable machines to do tasks which would otherwise be dangerous or unsafe for humans to perform.

HARDWARE VS. SOFTWARE

What are the differences between these two data processing terms? *Hardware* refers to the actual equipment used, such as the accounting machine, computer or automatic printer. *Software* refers to the sets of instructions and programs by which the equipment is directed to perform tasks. The instructions are usually in code form or computer language. Software may be in the form of an accounting program by which batches of data are sorted out in certain patterns and summarized in hard copy form, for example.

FIGURE 6—The language of data processing will seem peculiar at first, but you'll soon learn the special meanings of terms.

machine to use vacuum tubes was the ENIAC (Electronic Numerical Integrator and Computer), which was perfected in 1946. This monster of a machine occupied some 3,000 cubic feet of space and weighed in at more than 60,000 pounds. It had approximately 19,000 vacuum tubes, 70,000 resistors, 10,000 capacitors, 7,500 relays and switches, and consumed 140,000 watts of electricity. A small army of technicians hovered around it, finding and replacing burned-out tubes and trying to keep it running. Even with constant attention, it could only run a few hours at a time without breaking down. For all its size and electronic complexity, ENIAC's memory could only accommodate what today would be considered a small program. The first mass-produced computer, the UNIVAC, was placed on the market in 1951 by the Sperry Rand Corporation. This machine embodied the stored program concept. It was a decimal and alphabetic machine, had magnetic tapes, and used mercury-delay memory.

The International Business Machines 701, introduced in 1953, used binary numbers. This machine had an electrostatic memory which was considerably faster than the mercury-delay memory used in UNIVAC. Consequently, the 701 operated at much faster speed than the UNIVAC.

About this time magnetic core memories were developed which led to dramatic increases in processor speeds and memory capacities.

The various generations of computers are distinguished by two characteristics: the components of the electronic circuit (hardware), and the sophistication of the software. (Software is the collective name for the programs which enable the computer to be used.) Thus, first-generation computers employed vacuum tubes as the electronic components; the programs were simple and had to be read into the computer with the data each time they were required.

Second-Generation Computers

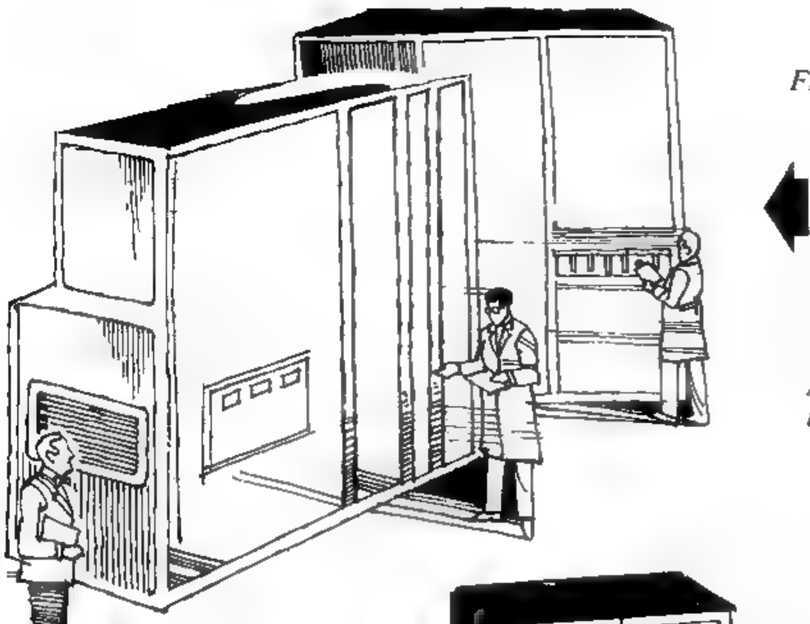
These employed semiconductor transistors in their circuitry. This reduced the size of the computer and increased its operating speed and its reliability. Relatively simple operating systems were developed, which considerably eased the operation of the computer. Magnetic tape and disk units were developed and were used to store programs.

Third-Generation Computers

These computers rely on integrated circuits as the electronic building blocks. These are extremely small components which are equivalent to a large number of discrete components and their interconnections. Integrated circuits allowed further reduction in the size of computers, but their major advantages are improved speed and reliability. The third generation also saw the development of complex operating systems allowing near automatic operation of the computer.

Modern computers are third generation, although it has been suggested that the recent development of sophisticated operating systems represents a fourth generation. It is anticipated that in the immediate future it will be computer software, rather than hardware, which will be developing most rapidly.

EVOLUTION OF COMPUTERS

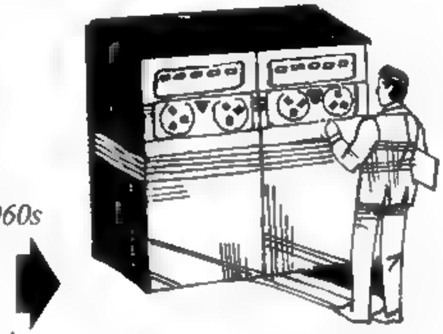


FIRST GENERATION: 1940s

3,000 cubic feet
60,000 pounds
19,000 vacuum tubes
70,000 resistors
10,000 capacitors
7,500 relays
140,000 watts of electricity

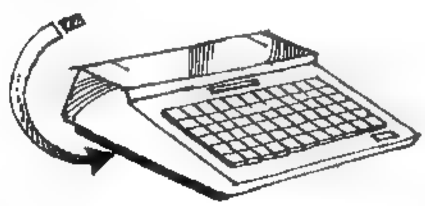
A few hours running before tubes burned out.

The vacuum tube was at the heart of early computers.



SECOND GENERATION: 1960s

- *Semiconductor transistors*
- *Magnetic and disk storage*
- *Reduced size; greater speed*
- *Simpler operation*
- *Greater reliability*



Where's the computer? It is a tiny microprocessor no larger than a dime, which fits under the keyboard! This processor has more capability than the first-generation computers!

THIRD GENERATION: 1970s-80s

- *Integrated circuits used as electronic building blocks*
- *Microsized computers can fit into attache' case*
- *Greater network integration (hooking several computers together)*
- *Incredible speed and reliability*
- *Near automatic operation*
- *Ability to monitor and troubleshoot own system*
- *Ability to reject or accept commands and data based on internal controls*

FIGURE 7—Computers have become smaller and smaller while their memory and processing capabilities have increased enormously.

THE COMPUTER IMPACT

The development of computer technology to date has been extremely rapid. One aspect of this development has been the continuing reduction in cost per unit of processing. Modern computers are many times more powerful and much cheaper than their predecessors. This means that using computers is becoming more and more attractive financially compared to alternative methods, and computers are becoming even more widely used. Computer technology is still developing rapidly in a number of fields.

Today, computers exist in three basic varieties. These are:

1. *The microcomputer* (also referred to as the *personal computer*). These are the smallest of the lot, in size and in memory capacity. We will have much more to say about micros, later.

2. *The Minicomputer*—No clear-cut separation has been established to distinguish a minicomputer from a microcomputer. However, a few features set minicomputers slightly apart.

   Minicomputers tend to be somewhat larger—not physically, but in electronic capacity. Generally, then, minicomputers have more memory capacity than micros, and there are other technical differences which enable them to operate faster than the micros do.

3. *Mainframe Computers*—Largest of the family is the mainframe computer. They are large in size and have very extensive memory capacity.

   Another distinguishing factor among the three types of computers is the program language each will accept. The microcomputers most often are programmed in a computer language called BASIC.

The microcomputer is the one you will learn to operate in this course. More importantly, you will learn to operate it using *BASIC* language. Many of the principles and rules that you learn will also apply to the larger computers, but we will be primarily concerned with the operation of the microcomputer and the BASIC language, from this point forward.

THE MICROCOMPUTER AND THE MICROPROCESSOR

Micros are the computers you see sitting on desks or tabletops, in homes, schools and offices. Their brain is a tiny microprocessor. The "computer on a chip" is a thin wafer of silicon about the size of a dime, containing the equivalent of over 10,000 electronic components. All our old ideas of computers as gigantic mazes of mysterious boxes connected by miles of cable, flashing and blinking their lights, are as obsolete as the dinosaur. The computers of today are becoming

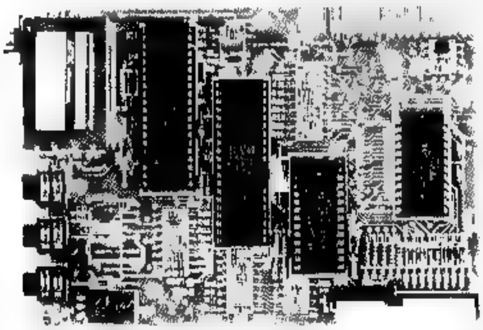
FIGURE 8—While companies need large rooms like the one above to house mainframe computers and peripheral equipment, many of today's managers and executives may also use a desk top microcomputer at the office, in meetings and at home.

both larger and smaller. Larger in capacity, smaller in size. As their physical size decreases, thanks to electronics miniaturization, their memory size and processing speeds are skyrocketing. Size, speed, memory and power consumption are important features of computer power. In spite of their small size, the micros are not watered-down big computer technology. Neither are they fads or toys. They are the product of state-of-the-art electronics technology and represent the future of the computer industry.

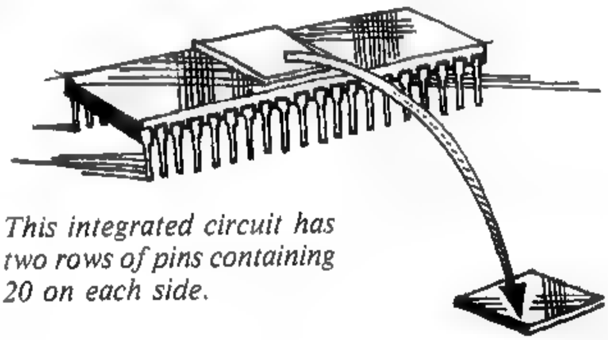
The groundwork for the microcomputer revolution was actually laid as far back as 1959 when Fairchild Semiconductor developed the integrated circuit (IC). The integrated circuit replaced the hundreds and often thousands of feet of conventional wiring with circuit paths imprinted on a small silicon wafer. Between 1959 and 1970 the electronics industry flourished, developing integrated circuits that could accommodate more and more circuit paths on smaller and smaller wafers. This push toward miniaturization was a direct result of our space program with its demands for lightweight but powerful electronics in the rocket ships that take astronauts into space. However, once the United States astronauts walked on the moon, interest and support for the space program waned and the electronics industry was forced to seek new applications for the technology. About 1971 the large-scale integrated (LSI) circuit, or "chip," came into being. All the circuits needed to make up the logic of a computer could be imprinted on an LSI chip and the microprocessor was born.

The microprocessor is the brain of the computer. Microprocessors are tiny "controllers," governing the operation of whatever electronic device they are part of. Almost every intelligent device designed for our convenience or entertainment has a microprocessor for its brain. Without even realizing it, we interact with microprocessor-controlled devices when we play video games, cook our dinner in microwave ovens, or make deposits or withdrawals at our local bank's automated teller machine. BMW advertises a car whose engine is controlled by microprocessors.

MICROPROCESSOR — BRAIN OF THE COMPUTER



Connectors (pinouts) on the Integrated Circuit make contact with other components inside the console housing.



This integrated circuit has two rows of pins containing 20 on each side.

The microprocessor chip (MPU) is the actual brain of the entire assembly.

FIGURE 9—Many people think of computers as complicated electronic instruments densely packed with parts and wires. They would be surprised to learn that the bulk of the work performed in a modern computer goes on in a tiny device no bigger than a fly. This is called a* microprocessor unit *or simply* MPU. *The MPU is a solid-state device, built on a wafer-thin slice of silicon called a "chip." The MPU chip is less than one-quarter the thickness of a dime. It is housed inside a multipin Integrated Circuit (IC) which is used to connect the MPU to other parts of the system.

The small step from microprocessor to microcomputer was made by mounting the microprocessor on a printed circuit board and adding other electronic components to connect to input and output devices and LSI chips for storage, timing and control. All this, together with some kind of case or container to hold it, is a microcomputer.

HOW A COMPUTER DOES ITS WORK

Now, let's see how we can communicate with the computer; how we can get it to "perform." To get the computer to carry out our wishes, it is necessary to "give it instructions." Groups of instructions that guide computer operations are called programs. Instructions, which make up a program, can be placed into the Random Access

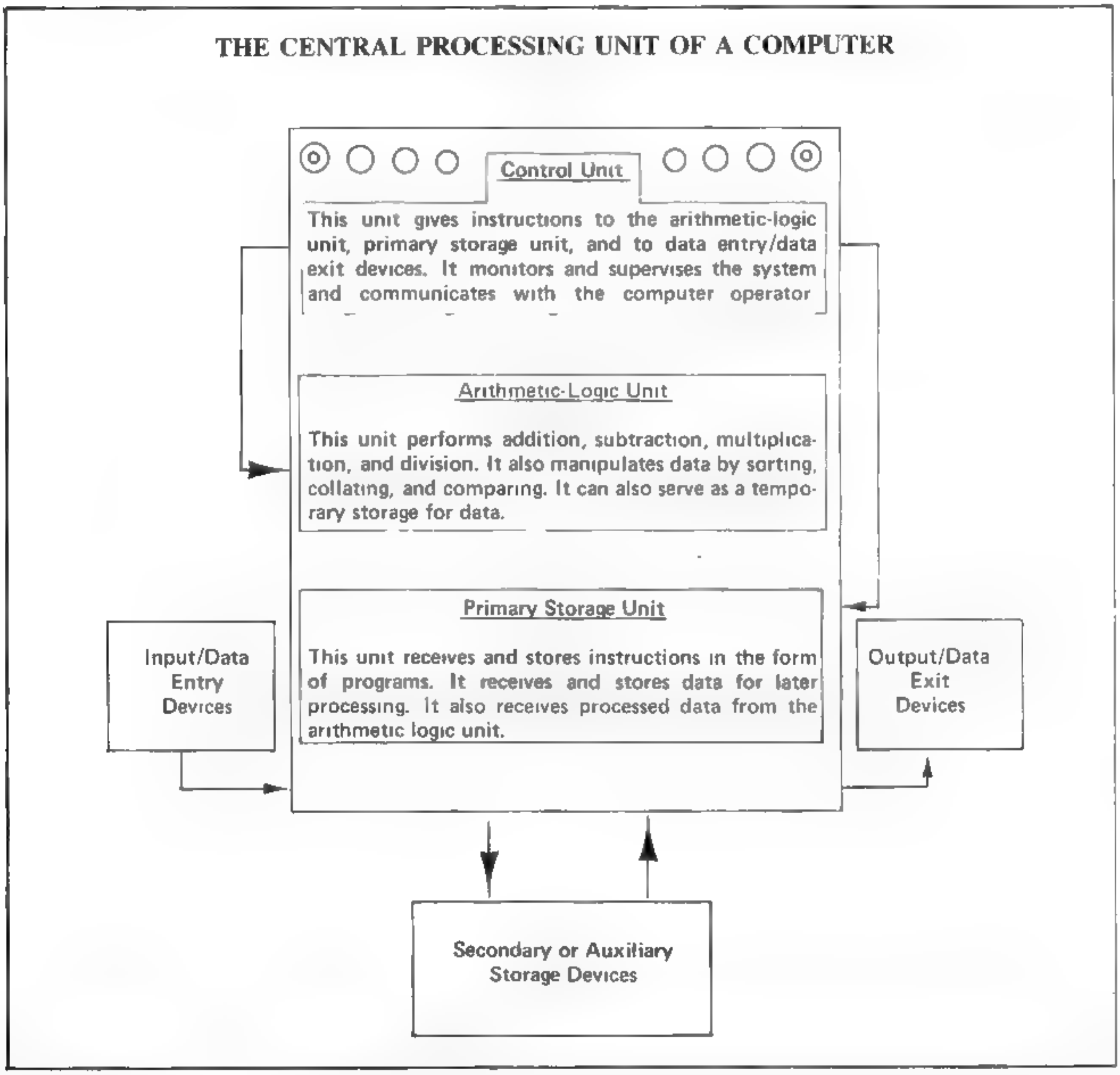


FIGURE 10—The Central Processing Unit or CPU is the nerve center of the mainframe computer. Instructions, calculations, and storage functions are performed here. The Microprocessor Unit or MPU fulfills the same functions for microcomputers.

Memory (RAM) of a computer. There are three ways to do this.

1. A computer operator types programs on the keyboard. The Central Processing Unit (CPU) diverts these instructions to temporary storage in the RAM memory section of the CPU.

2. Instructions are prepared and stored on magnetic tape in a cassette. Fed into the computer CPU from the cassette player/recorder, this kind of program goes to the RAM memory—just as do programs generated by keyboard entry. The instructions wait there until called for by the CPU or the computer operator.

3. A third way of getting information into a computer involves a combination of (1) and (2). Information stored on an audio cassette is fed into the computer via a cassette player/recorder. That information is then altered by putting in additional or replacement instructions by typing them via the keyboard.

The information and instructions we have just discussed involves what *you* put into the temporary (RAM) memory of the computer. Each computer is also outfitted with permanent routines which are placed there by the manufacturer.

These critical routine instructions are prepared before the computer is placed in operation. The computer designer incorporates these instructions into a tiny permanent ROM memory, and installs the memory in the CPU section. This permanent memory component is called the Read Only Memory; hence the initials, ROM. This "system" program—widely called the operating system program—guides the central processing unit as it initiates operations. (Computer users call this start-up of operations the "boot-up.")

Once you put your program (instructions) into the RAM of the computer, you can "run the program" (command the computer to carry out the instructions). The computer obeys instructions as it processes data—the chief activity of a computer. This processing must, of course, have some purpose.

INTERNAL COMPUTER STORAGE

FIGURE 11—Computer storage may be compared to the numbered mailboxes found in a post office. The computer can be instructed to enter information in any numbered location (box). It can also obtain information already stored here.

A typical task might be as follows: figure out the details of a loan: the monthly payments, the division of interest and principal in each payment, the total interest, the true rate of interest, and so on. A finance expert could figure it all out very quickly, using a good calculator. However, with a well-designed program, the computer requires no expertise at all on the part of the user—and the job is done in a minute or less!

The program "prompts" tell or remind the computer operator to enter, at the keyboard, whatever input data the program needs. Other data—such as formulas required for figuring out the details, say—are part of the program itself, previously stored in the memory along with the program instructions.

Although this is one type of program that a computer can run, it is a very simple program. The computer is able to run long, sophisticated programs that would otherwise require months of time for an army of people to prepare. And some things done with a computer simply cannot be done without it.

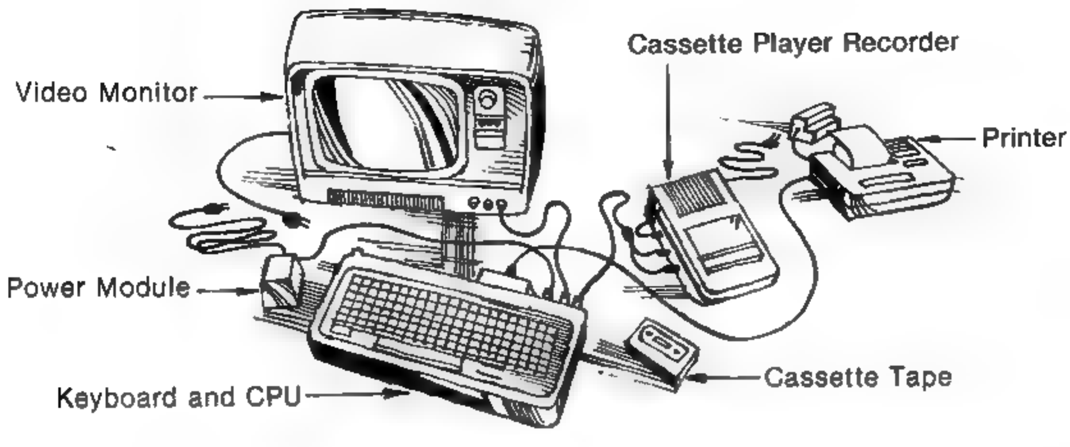


FIGURE 12—This is an example of a complete personal computer system. There is a keyboard for inputting; a central processing or microprocessing unit for computing, controlling and internal storing; a power module for proper voltage; a video monitor for displaying programs and data; a cassette player and tape for program and data loading and storage, and a printer for producing hard copy.

MICROCOMPUTER SYSTEMS

By itself, a microcomputer is not very useful. One problem is that once you turn it off, any program you have stored in its (RAM) memory vanishes. Also, you need to see, either on paper or on a display screen, your program and your results. A computer that keeps all results to itself doesn't do anyone any good. Consequently, the micro must be connected to (interfaced to or with) some other devices designed to store your program while you are not using it, show you your program statements and your results (like on a TV screen), save your data for reuse, and transmit saved programs and data back to the computer. The group of components used to accomplish these tasks comprise a microcomputer system. A good analogy is your stereo system—you have to connect up a receiver, speakers, tape deck and maybe other components before you have anything useful.

Some micro systems combine several devices in a single integrated unit so that one case contains the micro itself, a keyboard, a video display screen, a disk drive and maybe even a small printer. Others are distinctly piece-by-piece, with cables connecting the micro to the video or printer or whatever. Generally speaking, the devices you interface to your computer are for entering information (a keyboard for example), displaying results (printer or video screen), and storing either programs or data (disk drives or cassette recorders).

GETTING THE MICROCOMPUTER REVOLUTION GOING

At the same time the LSI chip was being perfected, the cost of producing it was zooming downward. By 1974 programmable microcomputers were on the market and were reasonably affordable. If the technology has been around since

1971 and micros have been available at a reasonable cost since 1974, just why has it taken all this time for the revolution to begin?

Probably the biggest obstacle to overcome was public resistance. Up to then computers were so expensive as to be an unthinkable purchase. Computer people "talked funny." To ordinary people, computers were the cause of errors in their utility bills, generators of junk mail, or agents of the IRS. "The computers did it!" was heard too often by frustrated customers trying to battle the red tape of stores or banks or utility companies. Throughout the 60s, the computer was regarded as the mysterious property of big companies and government agencies, understood and programmed by an equally mysterious group of people who seemed, to the outsider, to speak their own incomprehensible language. Actually buy one and take it home? Never!

Computer manufacturers were faced with the tremendous task of overcoming public suspicion and hostility, and re-educating people to think of the micro as a friend, not an adversary.

Besides, a friendly computer should act like one: it should be able to do something of value for you—and do it with the minimum possible fuss. If you have a business of your own, your computer should be able to handle your payroll or billing or inventory. If you have school-age children, it should have educational aids available and maybe games to entertain them (and you).

In the early and mid-seventies the micros were there, but the programs, or software, lagged far behind. Micros had great appeal for the hobbyist or do-it-yourselfer, but not much for anybody else. Potential customers from the business community found the price of micros attractive, but they were put off by the lack of software. What they wanted was to purchase their financial programs and be off and running immediately. Writing complex programs like a payroll system is time-consuming. Fortunately, a number of individuals and companies saw the value (and profit) in writing software for micros, and there are now many excellent programs on the market, with new ones arriving all the time. The available programs span all disciplines and interests, from games to engineering, from home finances to word processing.

Bits & Bytes

WHAT ARE BITS AND BYTES?

Data and instructions inside the computer are in the form of electrical voltage. The smallest particle of data is called a *bit*. Several bits are required to make up one identifiable piece of data known as a *byte*. Usually, bits travel in groups of eight or 16, making up one byte. Since each group of bits has its own distinct pattern, one byte is different from another. Each pattern or byte has its own meaning and forms a sort of code.

FIGURE 13—The actual machine language of computers is a combination of ones and zeros, a BINARY code. The smallest particle of meaning is known as a bit. And although it is common for eight bits to comprise one byte, some computers are made to have 16 bits in a byte.

THE PERSONAL COMPUTER

Back in 1978, when Radio Shack first backed its TRS-80 micro with heavy advertising, they aimed for the hobbyist or customer who wanted a bit more than a home video game or a calculator—someone who would buy a computer and take it home. They were looking for someone who wanted a computer to help with the family budgeting, keep track of bills or insurance records, plan meals, teach the children, help with homework or play a friendly game of chess. In other words, the TRS-80 was advertised as a *home computer*.

Other companies quickly offered their versions of the home computer. The VIC-20, APPLE II, Sinclair ZX81, Timex Sinclair 1000, and Atari 400 are just a few of the major ones. But the home

computer soon began showing up in offices, schools, factories, salesmen's briefcases and on phone lines, talking to larger computers.

Obviously, if the home computer couldn't be kept strictly at home, then it really wasn't a "home computer." It didn't have quite the memory or speed of the larger micros, but people were finding more ways to use it than its big brother micros. Marketing departments rose to the challenge by calling it the *personal computer.*

The distinction between the larger micro systems and personal systems is becoming more blurred as people are hooking up their personal computers to letter quality printers for word processing and to disk drives to handle more data storage. They are also buying additional memory in the form of chips or cartridges. People are busily adapting the larger-scale programs to their system size and capability. The entire distinction between personal and other micros is fast disappearing.

MICROCOMPUTING NOW

At last, here in the '80s, the revolution is in full swing. Microcomputers are affordable for both home and business. They are easy to use and easy to program. There are enough programs already written to enable anyone to put his micro to use immediately. There is also a ready market, even a desperate need, for well-written new programs of almost any type.

Just what are micros used for? More precisely, what kinds of programs are run on microcomputers? The real answer is that you can run just about anything on a micro—any program that can be made to fit in its memory is fair game.

In a business environment, it isn't cost-effective to use mainframes and minis for small programs, so these are a natural for micros. But there's nothing to keep an ambitious micro from invading some of the "big program" areas, if it has enough memory and enough time.

Micros also have the distinct advantage of portability. They can sit at home, go with you to show off for friends, make the rounds of clients with salesmen, go out into oil fields or into board rooms, live in offices, stores, schools, churches or factories. In short, you can pick up a micro, take it to where it is needed, plug it in, and it's ready to go. It is ideal for short, quick jobs that don't need huge amounts of memory and in situations where you don't mind that it can only run one program at a time.

WHAT ABOUT PROGRAMS?

All programs start out as wishes. Someone, somewhere, saying:

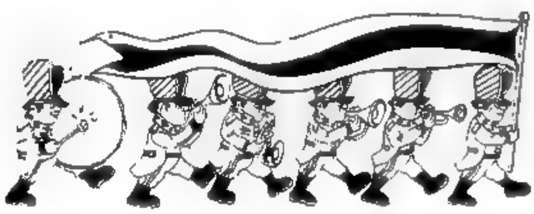
- "I wish I didn't have to fill out all these reports."
- "I wish I could balance my checkbook."
- "I wish I could order supplies for all my restaurants at once."
- "I wish I could help my kids with their math."
- "I wish I could chart the performance of my favorite stocks."
- "I wish I knew where I put my insurance records."
- "I wish I had someone to play chess with."
- "I wish I had a list of my stamp collection."
- "I wish I could analyze the horse races; I just know I could make a lot of money."
- "I wish I had a mailing list of my clients."
- "I wish I had an accounting system."

When you or someone else actually writes or buys the program to do the job, the wish list is transformed into reality.

Look again at the wishes. Most of them are personal or related to small business problems (or small problems of business). Nothing like "I wish I could analyze satellite data." Leave that for the mainframes. All of those wishes above can easily be fulfilled on a micro. In fact, every one of them has been programmed in BASIC—plus hundreds more

BASIC: THE LANGUAGE OF MICROCOMPUTING

Where does BASIC fit into the revolutionary picture? BASIC is THE language of microcomputing. It is by far the most popular and widely used language for programming micros—to such an extent that most micros now "power up" with BASIC. That is, as soon as they are turned on, they are ready to accept and run programs written in BASIC. Everything they need to handle BASIC programs has already been made a permanent part of the computer at the factory. Micros which don't power up with BASIC usually have it available on a hardware component or chip, which can be purchased and plugged into the internal circuit board.



A PARADE OF BYTES EQUALS... A PROGRAM!

A sequence of instruction bytes and data bytes is called a program. Each instruction byte informs the microprocessor as to what to do with the associated data bytes.

A microprocessor may add data bytes, subtract them, compare them with other bytes, alter their bit patterns, and perform other operations with the bytes of data it receives. It can even create new bytes if an instruction tells it to do so.

FIGURE 14—The arrangement, type and number of bytes and bits are critical. The microprocessor, programmer and program user work together so that the program performs according to requirements.

A word of explanation is in order here. Computers need programs of their own in order to run your programs. The micro's programs convert your BASIC program into commands which the computer can understand. Your native language might be English, but your micro's isn't, so an "interpreter" is necessary to bridge the communication gap. The computer's own programs also perform other tasks like memory management and housekeeping to keep things running smoothly.

It is inevitable that dialects spring up in any widely used language, whether English, French, German or BASIC. Dialects of BASIC are invented to offer some desirable feature for specific applications such as specialized printing or graphic displays. They are also used to take advantage of some particular capability of a piece of hardware like a letter quality printer or a plotter. Another reason for the development of these dialects is the marketing of "turnkey" systems—computer systems sold as complete units to perform a single task like financial accounting. Turnkey systems are a total package: micro, printer, disk storage, and all the software to do the job. Many companies which put turnkey systems together develop their own version of BASIC and write all their software in their own dialect. However, regardless of how many versions of BASIC there are around, they are all easy to learn; and once you learn one, the differences are minor. Just like a Southerner can converse with a Bostonian, two versions of BASIC are still fundamentally BASIC, built on the same 40-odd commands.

BASIC programs handle general-purpose accounting as well as the special needs of medical and legal systems. They make airline reservations, teach math, history, spelling, geography, chemistry and foreign languages. They compute utility bills, calculate mortgage payments and real estate costs, plan household budgets and even

Accounting Payable
Accounts Payable/Purchase Order
Accounts Receivable
Accounts Receivable Balance Forward
Accounts Receivable/Sales Analysis
Address File
Agenda Files
Alien Attack (Game)
Alien Cruiser (Game)
Alphabetize Lists
Analysis of Two Vectors
Angle Conversion: Degrees to Radians
Angle Conversion: Radians to Degrees
Annual Interest Rate on a Loan
Apartment Building Investment Analysis
Apartment Manager
Appointment Calendar
Area of a Polygon
Asset Record System
Auto Records
Average Growth Rate, Future Projections
Basic Accounting System
Basic Business Inventory
Bill of Materials
Billings Management
Biorhythms
Blackjack
Business Accounting
Business Check Register and Budget
Cash Receipts System
Check Disbursements Posting System
Checkbook Balancing
Check Writer
Chi-Square Distribution
Chi-Square Test
Client Accounting System
Commercial Property System
Company Purchases
Company Sales
Constellation (Game)
Construction Accounting
Construction Cost Profit Analysis
Contract Billing
Contractor Job Cost
Coordinate Conversion
Coordinate Plotting
Cost Accounting
Crown & Sceptre (Game)
Curvilinear Interpolation
Datebook Appointment Calendar
Days Between Two Dates
Depreciation
Depreciation Amount
Depreciation Calculations and Reports
Depreciation Rate
Diet Analysis
Discount Commercial Paper
Earned Interest Table
Effective Interest Rate on Investment
Executive Accounting System
Exponential Regression
Federal Withholding Taxes
Financial Analyzer
Financial and Management Accounting
Financial Reporting
Fixed Accounting System
Fixed Asset Accounting
Fixed Asset Depreciation
Fixed Asset Depreciation Schedules
Future Value of an Investment
Future Value of Regular Deposits (Annuity)
Galactic Commando (Game)
Galaxy Invaders (Game)
Galaxy Warrior (Game)
General Accounting
General Ledger
Geometric Mean and Deviation
Geometric Regression
Gobbleman (Game)
Greatest Common Denominator
Grocery List
Gunfighter (Game)
Hangman
Home Finance
Home Inventory File
Home Purchase Analysis

FIGURE 15—Here is a sample list of software that you can run on a personal computer. Depending on the personal computer that you have, certain of these programs are available on cassette tapes and can simply be loaded into your machine. Additionally, when you know how to program your computer, you will be able to adapt preprinted programs (available for purchase), and keyboard it into your machine—or, write the program yourself.

Inca Curse (Game)
Income Property Analysis
Inheritance
Initial Investment
Inventory Accounting
Inventory Control
Inventory Management
Invoicing
Job Accounting System
Job Cost Accountings
Last Payment on a Loan
Linear Correlation Coefficient
Linear Interpolation
Linear Programming
Linear Regression
Listings
Magazine File
Manufacturing Inventory Control
Marketing Systems—Proposal Developer
Matrix Addition, Subtraction, Scalar Multiplication
Matrix Inversion
Matrix Multiplication
Mean, Variance, Standard Deviation
Membership Billing
Minimum Investment for Withdrawals
Mortgage Amortization Table
Mortgage Analysis
Multifile Plus Data Storage System
Multiple Linear Regression
Nominal Interest Rate on Investments
Normal Distribution
Open Item Accounts Receivable
Operations on Two Vectors
Order Entry and Billing
Order Entry and Invoicing
Order Entry Inventory Control
Parts of a Triangle
Permutations and Combinations
Personal Accounting System
Personal Datebook
Personal Expense Record
Personal Finance Manager
Personal Financial Planning
Planet of Fear (Game)
Plot of Functions
Plot of Polar Equation
Poisson Distribution
Popstar (Game)
Prime Factor of Integers
Principal on a Loan
Progressive Billing
Project Scheduling
Property Analysis System
Property Management System
Purchase Order System
Real Estate Analysis Program
Recipe Cost
Regular Deposits
Regular Payment on a Loan
Remaining Balance on a Loan
Rent vs. Buy
Rental Manager
Residential Property Management
Retail Inventory
Roots of Quadratic Equations
Sales Analysis
Sales Invoice
Sales Ledger
Sales Order Processing
Sales Prospect Management Package
Sales Tracker
Salesmen Monitoring
Salvage Value
Simultaneous Equations
Stock Control
Stock Recording
Survey Check (Map Check)
System Reliability
Tax Depreciation Schedule
Term of a Loan
The Landlord-Property Mgmt. System
Time Manager
ZX Galaxians (Game)
ZX Chess II (Enhanced) (Game)
1K ZX Chess (Game)
ZX Scramble (Game)
ZX81 Mathematics: Grade One
ZX81 Mathematics: Grade Two
ZX81 Mathematics: Grade Three
ZX81 Mathematics: Grade Four
ZX81 Mathematics: Grade Five
ZX81 Mathematics: Grade Six
ZX81 Personal Weight Control Program

FIGURE 15 continued

meals and grocery lists. Other BASIC programs create mailing lists, print newsletters, keep church records, maintain parts lists or just about any kind of list you can think of. There are home programs, office programs, office-at-home programs, educational programs, games, hobbies and some, like biorhythm programs, that defy classification.

Great! Now, how do you get all these programs? As we have previously suggested, there are three main ways: you write them yourself; or you buy them; or you buy them and modify them to meet your own job needs. (You can also swap programs with friends, but your choices will probably be rather limited.) Since you will be learning how to write your own programs in this course, transforming your own wish list into BASIC programs, let's assume for now that you want to buy a program. Buying a program can be done in several ways; the difference is in the medium the program is on. You can buy a program on a disk, on a cassette tape or in a book. Disks are the most expensive, and of course you need a disk drive interfaced with your micro. Cassette tapes are much cheaper, but it takes longer to load a program from tape than from disk. With disks you pay extra for speed and convenience, plus the increased cost of the disk itself.

The cheapest way of all is to buy a book of programs; and books of BASIC programs abound. For under $15 you can buy a book containing the printed lists of all the program statements of 20 to 50 BASIC programs. The disadvantage here is that you have to type the programs into the computer yourself, then save them on your own cassette tape or disk.

Obviously, all programs are not available on all media, but you can generally locate what you want or something close to it which you can customize to suit your particular needs. Most experienced programmers, and businesses too for that matter, use a combination of writing their own software *and* buying, or buying and customizing. That is likely what you will be doing, too. They write the programs that are special-purpose and can't be found elsewhere.

THE FUTURE

In the office, micros are changing the entire nature of business thinking and communication. One of the most powerful combinations to emerge is that of the micro plus telephone, giving small companies equal access to data and communication links that previously were the privilege of only the giants. In an environment where productivity is frequently confused with the weight of the paper work generated and stored, micros are being used to store one copy of a memo or letter or document, with additional copies printed "on demand."

Even small businesses are buying not one or two micros, but half a dozen or more so that everyone from clerical staff to management can have quick access to one. An automated office can be thought of as an office environment in which the structured and mundane work has been computerized or performed as much as possible by mechanical devices, and the balance of the work is assisted or enhanced by computers.

The household of the future has been likened to a giant, multipurpose appliance, functioning under the control of the household computer. While a total household information and communications system would be prohibitively expensive right now and probably not for everyone, most of the bits and pieces already exist in some form or are under development. Rather than a full-scale, all-encompassing system, the household of the future will be a selective combination of subsystems, custom-tailored to fit individual needs and preferences. Some of the subsystems offer such obvious benefits that they are expected to become household standards—in fact they are available now in self-contained form. The next logical step is placing them under control of the computer for coordination and communication. These subsystems are, of course, the intruder detection and alarm systems, the energy monitoring and control devices, and the special communications links that call paramedics, police, fire or other emergency assistance.

In the nice-to-have category are automatic bill paying and banking at home, appliance control and access—on request—to information or services like news, weather, travel, libraries and community announcements. It would also be nice to call

up your computer via telephone and receive a household status report, family messages and phone calls. However you put the pieces together, the system of the future will combine your computer, telephone and television to monitor your household and automatically link you to the outside world.

YOU, YOUR PROGRAM AND YOUR MICRO— A TEAM EFFORT

Now it's time to show you how you and your microcomputer will be interacting. Follow the concepts through, and you are on your way to computing power. Responsibility is the key issue here—what is yours, what is your micro's, and what is your program's. Obviously, you are the one who writes the program and the computer is the one that executes it, but there's a lot more to it than that. Roughly speaking, you are responsible for writing the program, getting it into the computer, instructing the computer to run it, and providing any input data needed. It is the computer's job to recognize that you are entering a program, store it in its memory, recognize your command to run it, and finally, provide a program of its own—via the BASIC Interpreter—to execute your program commands. Your program's duty is to request input data, operate on it and display the results back to you on your television screen. If you do not write program statements to get data in, then none will ever get to your program. Likewise, if you have not included any output-type statements like PRINT in your program, you will never see your results. They will have been calculated and placed in memory, but they are never automatically displayed.

YOU CAN'T HURT IT

One final word of comfort. There is absolutely nothing you can do, short of physical abuse like dropping it or putting it in the freezer, that will do any permanent damage to your micro. Feel free to type in anything from the keyboard. Your micro may complain that it can't understand what you want, or it may be so offended that it will go away and sulk, but you and your program can't possibly hurt it.

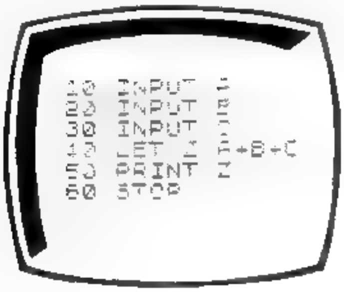
The very worst that can happen, and most likely will, will happen to you, not your micro. You will have wasted some time and effort typing your program in, and you will have to do it all over again. Here's how this happens—and be prepared; it happens to everyone! You type in your program and are so anxious to try it out that you forget to save it on cassette tape, or you're so confident that you think your program can't possibly fail, so you don't save it. You type RUN and nothing happens. And nothing happens. And nothing happens. After a while you get suspicious and press STOP. Still nothing. The computer won't respond no matter what you type. What has happened is that your program has some error that caused an important memory location to change, and your computer just can't find its way back to you or it's waiting for something to happen. In any case, your last resort when the micro won't respond is to TURN IT OFF, wait a few seconds, then turn it back on. When it is back on everything is fine, with just one exception. Your program was erased when you turned the micro off. Your only recourse is to type it all in again and remember to save it before you run it so at least next time you can load it in from the tape instead of retyping it all. You should know that turning the computer off then back on does not correct whatever error caused it to go away. That error is in your program, and you have to find it and fix it or the same thing will happen again. The important thing to remember is that your program never does any permanent damage to the computer; it can only temporarily confuse it.

COMPUTER POWER— YOURS FOR THE DOING

This is the beginning—you have begun. By applying yourself to your lessons, *you will learn a lot* about computer programming in a short time. Then, more slowly, but still at a good pace, you will be writing programs. More and more, better and better as you go. Then, before you know it, you will have COMPUTER POWER—you will have your own genie to begin fulfilling your wish list. What better time than now to begin learning how to program. As a final section of this first lesson, you will have the opportunity to actually write a program in BASIC.

WRITING A PROGRAM IN BASIC

There are certain prescribed features and procedures when writing a computer program. For example, each program command appears on a separate line. And, each line of instructions is designated by number. If you wanted to add three figures and arrive at a total, you could do this using an adding machine or calculator. Suppose, however, that you wanted to perform this same function, adding three figures, over and over again using different figures. This is a job for a computer program. Following is the program in BASIC Language for this task:



What does this program mean? Well, the first line begins with 1∅, which indicates to the computer that you are giving program instructions. INPUT is a signal to the computer that certain data will be fed into the computer for processing. In this instance, the input will be called A.

Lines 2∅ and 3∅ signal more input, called B and C. Line 4∅ is the formula which will be used to perform the calculation to arrive at Z, the answer: LET Z = A+B+C.

The 5∅ line indicates still another program instruction. This time, you are requesting the computer to PRINT Z or, in plain English, to give the answer.

Line 6∅ provides a final signal that the program is ended. You, the programmer, signal this by programming STOP. Before running the program, let's see what took place as you loaded the program.

Placing the sequence numbers 1∅, 2∅, 3∅, 4∅, 5∅, and 6∅ before each line signaled the computer that you were feeding in *program or instruction* material as opposed to feeding in raw data. After examining the complete program, it is time to check it out and see if it will work.

This means you have to inform the computer to "RUN" the program. At the split second you enter RUN, the BASIC interpreter scans the program line by line and translates the message into machine language (BINARY). RUN also commands the computer to prepare to receive data, so you are ready to feed the raw data into the computer for processing.

DATA INPUT

Now is when you must tell the computer what A, B, and C are in this particular run. They can be any numbers you want them to be—whatever three numbers you need to add together. Suppose you wanted the three numbers to be 1∅ = A, 15.862 = B and -22.1 = C. You would enter them one at a time, as follows:

1∅
15.862
-22.1

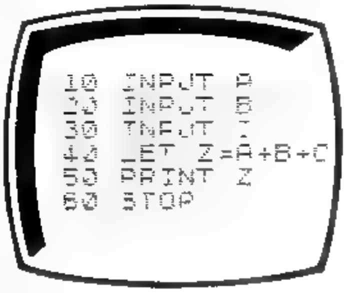
The computer goes to work instantly, by first storing the data, then processing it according to the program. After scanning the next line of program and getting values of A, B, C, the sum is stored as Z.

When scanning the next line, the computer prints the value of Z (the answer) on the screen.

Scanning continues to the next line, which the computer recognizes as STOP. To repeat the calculation with different numbers, simply enter RUN and input new data.

A VIDEO SCREEN SHOWS SEQUENCE OF STEPS

Here is how your program would appear on the video display screen.



Upon depressing the RUN key, a reverse L will appear (which asks you for your input). Put in your value for A, press ENTER, put in your value for B, press ENTER, put in your value for C and press ENTER. Your answer will appear in the top left corner of the screen.

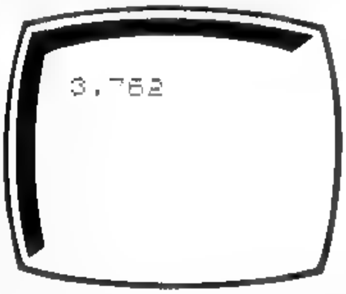
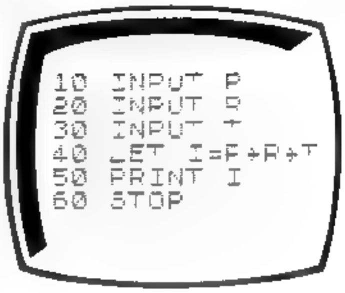


FIGURE 16—Being able to read program and data input assures that the programmer and operator can check the input for accuracy. If there is an error showing on the screen, it can be corrected much like you would correct an error using a corrector typewriter.

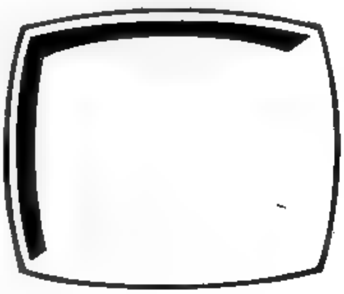
Now, pause for a moment and complete the Programmer's Check which follows. Write your answers or do your calculations in the space provided. Then, check your answers with those on the page specified.

Programming has applications in virtually every area of life. As you can see from the previous exercises, once you have placed a program on the computer, you can feed in as many different variables as you require. Imagine the time saved by having the program already in place, ready to accept and process figures.

Consider, for example, how a computer program such as figuring interest rates can save bankers and investors thousands of error free hours. Remember the formula *Interest equals Principal times Rate times Time*? We learned to abbreviate this down to I = PxRxT. This program can be fed into the computer in the following form:



Now, suppose you were a banker and had 10 or more customers every day asking you to figure the rate of interest on loans. How long would it take you? Seconds! For example, a customer wants to borrow $20,000 for two years at an interest rate of 12%. You could calculate this problem using a pencil and paper or using a small calculator. But if you have to do this same sort of calculation every day using different figures, your computer program is the answer. Can you display the correct printout for the banker's problem?



(Answer on Page 24)

PROGRAMMER'S CHECK

Using BASIC Computer Language

Now, using what you have learned about programming in the previous section, let's find out whether you can apply it correctly to a new situation. Following are program and data input instructions. Use these to develop a program and obtain solutions by running the data. You can use a calculator or pencil and paper to perform the mathematics after the runs.

PROGRAM SPECIFICATIONS

You want to multiply four different figures together to obtain a total. The symbol used for multiplying is the asterisk. This symbol is placed between each of the numbers to be multiplied.

Example: 8*7 = 56

DATA INPUT

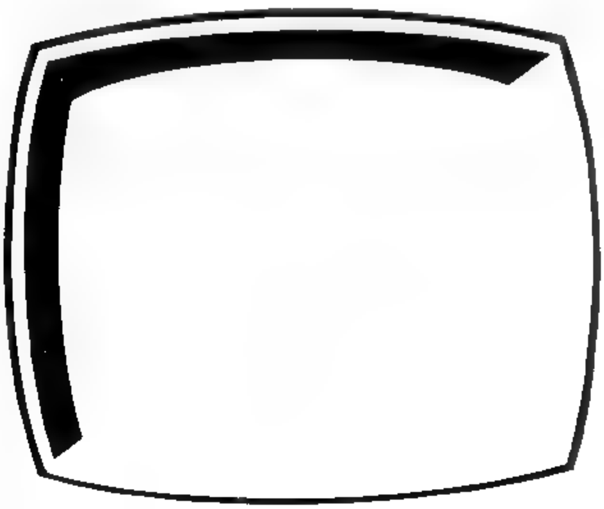
First Run: 3, 4, 2, 2

Second Run: 3, 9, 2, 2

Third Run: 5, 2, 3, 2

(Answers on Page 24)

NOTE PAD



You can readily see from using these simple programs how nearly any formula can be entered into a computer so that figuring becomes a breeze. Once the program has been accurately entered, the only chance for error is when inputting the variable figures. And, since all figures are displayed on the CRT, you can always check and recheck your input for errors.

By this time, you have a pretty good notion about how micro "chips" are revolutionizing our lives. Computers are becoming more powerful and are used in products from microwave ovens to pocket calculators. BASIC language and "dialects" of BASIC enable anyone to operate or to program a microcomputer.

In this lesson you have learned a bit about the history of computers. You learned some of the terms used by programmers such as RAM, ROM, input, software, etc. And, you have already tried your hand at programming.

You are already discovering, perhaps, that the powers of the computer are similar to those of the magical genie, but these powers can be understood. By learning more about computer programming, you can draw upon the powers of the computer to do your bidding. You will hold these powers at your fingertips, to use any time you want.

After reviewing what you have learned in this lesson, take the examination which follows. You are well on your way into the world of microcomputers and programs.

DO YOU KNOW NOW?

These were the questions posed at the beginning of the lesson.

- **How micro "chips" are revolutionizing our lives?**
  CPU and memory chips are so powerful and so small that they can be used to control everything from watches and cameras to microwave ovens and space satellites. New discoveries in science, medicine, and technology have resulted from the miniaturization and lower cost of "chips."

- **What language is used by micro and personal computers?**
  BASIC and dialects of BASIC are used by most microcomputers. Many are capable of understanding other languages, too, but BASIC is the standard language of the micros.

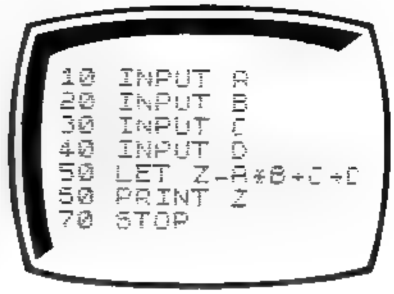
- **How computers operate: what they can and cannot do?**
  Computers are not magical. They can only perform functions according to the limitations and possibilities of ROM, RAM, and the programs and data entered. The ability of the computer to store and retrieve bytes of data composed of eight or sixteen bits each is fundamental to computer functioning. The on/off, zero or one concept of machine language is at the heart of understanding how a computer can store and process data and software.

PROGRAMMER'S CHECK ANSWERS

First Run: **48**

Second Run: **1Ø8**

Third Run: **6Ø**



This is how the program would appear on the video screen.

ANSWER TO BANKER'S PROBLEM

SCHOOL OF COMPUTER TRAINING

EXAM 1

THE MAGIC OF COMPUTERS

4701-3

When you feel confident that you have mastered the material in Study Unit 1, complete Exam 1. When you have completed the entire Exam, transfer your answers to the Answer Sheet which follows.

Questions 1-10: Circle the letter beside the one best answer to each question (10 points each).

1. Programs such as mathematical formulas and data such as numbers are

   (a) hardware.
   (b) peripherals.
   (c) hard copy.
   (d) software.

2. The "brain" of a computer is called a

   (a) central processing unit or microprocessor unit.
   (b) memory.
   (c) keyboard.
   (d) disk.

3. A computer operator depends upon the programmer to

   (a) write programs to meet user needs.
   (b) obtain existing programs to meet user needs.
   (c) adapt existing programs to meet user needs.
   (d) all of the above.

4. Compared with microcomputers, mainframes and minicomputers are

   (a) larger in memory capacity.
   (b) smaller in memory capacity.
   (c) identical in memory capacity.
   (d) without memory.

5. The RAM or "scratch pad" storage area of the computer is

(a) Random Access Memory.
(b) Read Access Manual.
(c) Read and Memorize.
(d) None of the answers given.

6. ROM or Read Only Memory is the

(a) built-in memory installed by the manufacturer.
(b) data storage part of the computer.
(c) BASIC language.
(d) auxiliary storage of a computer.

7. You are the programmer for a freight company. You have been asked to design a program which will tell the dispatcher how far trucks can travel (Distance) within a certain time at a given speed. You use the formula: D = R*T for Distance equals the Rate times the Time. Which of the following programs would be correct?

(a)

```
1Ø  INPUT R
2Ø  INPUT T
3Ø  LET D = R*T
4Ø  PRINT D
5Ø  STOP
```

(c)

```
1Ø  INPUT R
2Ø  INPUT T
3Ø  LET D = R*T
4Ø  STOP
```

(b)

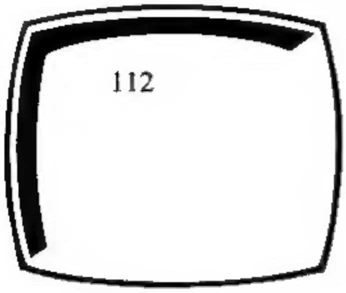
```
1Ø  INPUT R
2Ø  INPUT T
3Ø  LET D = R+T
4Ø  PRINT D
5Ø  END
```

(d)

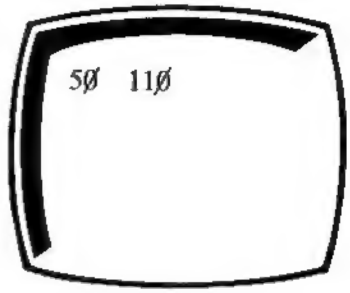
```
1Ø  INPUT R
2Ø  INPUT T
3Ø  LET D = R*D
4Ø  PRINT T
5Ø  RUN
```

8. If the dispatcher in problem number seven wanted to determine the distance covered by a truck which is traveling at 56 miles per hour for two hours, what would be the correct display?

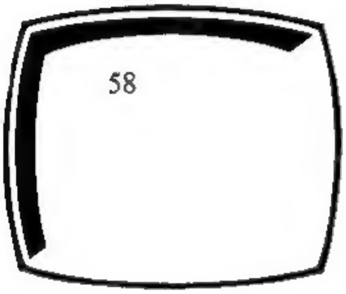
(a)



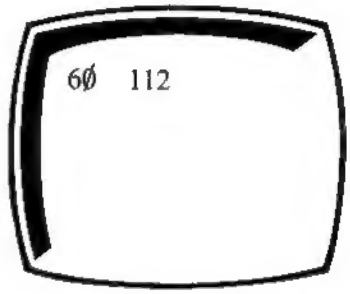
(c)



(b)



(d)



9. The smallest particle of data in machine language is a

(a) k or kilogram.
(b) byte.
(c) bit.
(d) binary.

10. Accounts payable, blackjack, invoicing, diet analysis, loan interest, and checkbook balancing are examples of programs which are available

(a) as software packages for the microcomputer.
(b) as software only on mainframes and minis.
(c) through the computer manufacturer, only.
(d) only on disk or cassette.

SCHOOL OF COMPUTER TRAINING

ANSWER SHEET

THE MAGIC OF COMPUTERS

Examination Number 4701-3

PLEASE PRINT

NAME ______________________ **STUDENT NUMBER** ____________

ADDRESS ____

CITY ______________________ STATE ________ ZIP ____________

☐ **Check if this is a new address and you have not previously notified us.**

— FOLD —

CUT ALONG THIS LINE

INDICATE YOUR ANSWER TO EACH QUESTION BY MARKING AN X IN THE APPROPRIATE SQUARE. EXAMPLE: ☒ B C D

1.	A	B	C	D	**6.**	A	B	C	D
2.	A	B	C	D	**7.**	A	B	C	D
3.	A	B	C	D	**8.**	A	B	C	D
4.	A	B	C	D	**9.**	A	B	C	D
5.	A	B	C	D	**10.**	A	B	C	D

— FOLD —